

New Features and Improvements in DYNA3D

DYNA3D is a simulation code for nonlinear structural dynamics. Its ability to model high-speed, large-deformation impacts of complex assemblies makes it a fundamental tool for national-security-related programs at LLNL. This project funds the implementation of user-requested features, general technical support, document updates, and Software Quality Assurance (SQA) compliance for DYNA3D. This project also supports Collaborator Program activities. The Collaborator Program grants access to selected licensed users to LLNL's computational mechanics/thermal codes in exchange for the collaborators' information and results. These collaborative parties include our sister laboratories, U.S. government agencies, and other institutions.

Project Goals

For FY2005, the planned tasks included the implementation of functionalities for various programmatic users' needs, the addition of new result display capabilities, and continued improvement of contact algorithms for modeling the interaction of material surfaces.

Relevance to LLNL Mission

Technical support and new functionalities are essential to ongoing uses for nuclear weapons engineering and projects involving LLNL's collaboration with other institutions and federal agencies, such as the Los Alamos National Laboratory, the Department of Homeland Security, the Bureau of Reclamation, and the Boeing Company.

FY2005 Accomplishments and Results

In FY2005, two new material models were implemented in DYNA3D. Several display capabilities were added through use of the Mili I/O Library and the postprocessor Griz. We also completed the first-phase implementation and assessment of an alternative segment-to-segment contact methodology. The preliminary results show promise for dealing with extreme contact situations.

A new concrete material was adopted in DYNA3D. This model is an improvement over the older material type, including a capability for self-generation of material model parameters. Given the user-provided key concrete strengths determined by

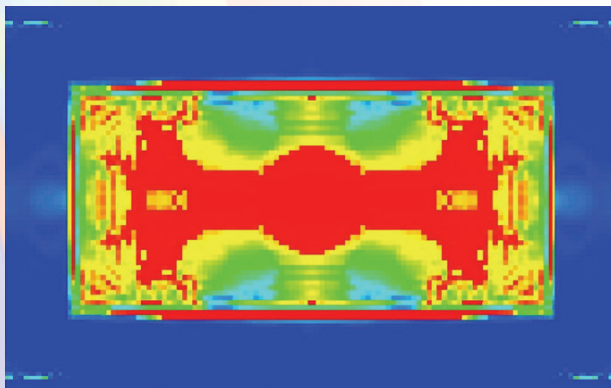


Figure 1. Stress distribution of a blast-loaded RC wall computed using the homogenized RC material model.

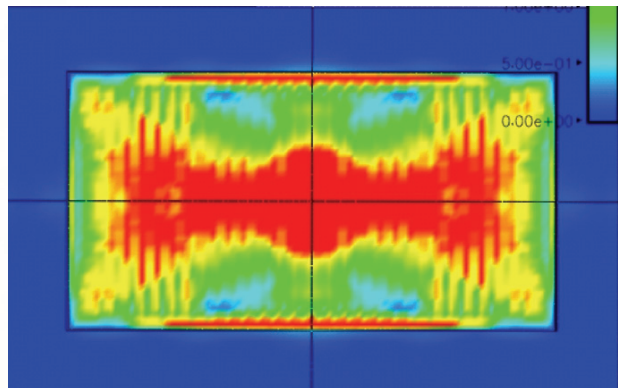


Figure 2. Stress distribution of a blast-loaded RC wall computed using individual concrete and rebar materials elements and material models.



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experiment, this model is coded to automatically generate the remainder of the necessary material properties.

Another new concrete-related material is a homogenized rebar-reinforced concrete model. This model was developed by another LLNL analyst, with this project providing collaboration and integration to the main DYNA3D source. This model integrates the presence of rebar into concrete material, hence alleviates the need for analysts to mesh reinforced concrete as an explicit combination of small concrete continuum and rebar beam elements.

A precision test of a blast-loaded reinforced-concrete (RC) wall was used to demonstrate the effectiveness of the homogenized concrete-rebar model. Two RC walls, one modeled via the new homogenized material and the other using small continuum and beam elements, were simulated

under the same blast loads. The close agreement shown in Figs. 1 and 2 attests to the value of the new material model.

In impact/penetration analyses, engineers often want to see the movement of the fragmented debris and monitor how the penetrator momentum changes over time. For this purpose, capabilities for displaying the released particles after material failure and the momentum time history of materials were implemented into DYNA3D and Griz.

A contact algorithm based on checking the interference between quadrilateral patches was studied as a possible complement to the existing contact algorithms in DYNA3D. The preliminary results are promising. One of the examples tested is the simulation of two colliding strips. This problem creates an edge-to-edge contact scenario, which the existing

contact algorithms do not handle well. Comparison between Figs. 3 and 4 demonstrates that the prototyped method captures the right phenomena.

FY2006 Proposed Work

In addition to the general technical support for DYNA3D users and SQA-compliance work, we also plan to start or continue the following projects:

1. A new surface class entity is nearing release in the Mili data management library. Upon its availability, it will be implemented into the DYNA3D output database. This new class will enable many additional result variables and parameters, including applied boundary condition specifications, to be included in the results database. This will enhance our users' ability to verify their problem specification and interrogate the results.
2. More implementation and assessment effort will be devoted to the prototyped contact algorithm. The planned tasks include coding optimization, efficiency studies and further application.
3. We will continue to modernize DYNA3D. All new features will be implemented under a uniform FORTRAN 95-compliant programming structure, and the existing code will be gradually migrated toward that standard as well.

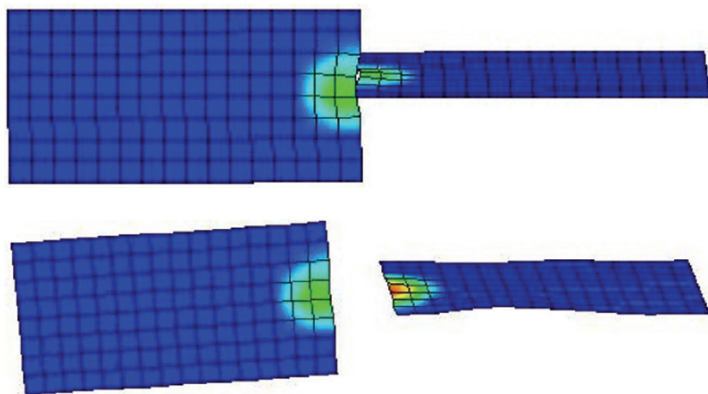


Figure 3. Colliding strips simulated using the new contact algorithm.



Figure 4. Colliding strips simulated using the existing contact algorithm.